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(54) Abrasive composition for scratch-free finish buffing

(57) Workpieces e.g. stainless steel are buffed to a scratch-free mirror finished surface by applying an abrasive composition to a buff, rotating the buff, and pressing the workpiece against the buff. The abrasive composition used is obtained by dispersing 3 to 20% by weight of abrasive grains with a mean grain size of up to 0.5 µm in water and adjusting the slurry to pH 1 to 5 with nitric acid, phosphoric acid or a nitrate. The abrasive grains may be one or more of aluminium oxide, chromium oxide, iron oxide and silicon carbide and the acidic component is preferably aluminium nitrate.

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SCRATCH-FREE FINISH BUFFING

This invention relates to a method for buffing articles such as workpieces of stainless steel or the like having curved surfaces and corners to provide a scratch-free mirror finished surface.

For stainless steel articles having curved surfaces and corners, for example, watch casings, eyeglass frames, tableware, pots and pans, golf clubs and the like, more attention is now paid to their surface lustre. There is an increased need for smooth surfaces substantially free from scratches, for both aesthetic and functional reasons.

Among prior art methods for the mirror surface polishing of such workpieces having curved surfaces and corners, buffing using grease-based buffing compositions is most commonly used. However, the need for a scratch-free smooth surface was not fully satisfied by such prior art buffing methods since defects and scratches were introduced into the ground surface by the abrasive grains in the compositions.

Also, electrolyte composite polishing in which workpieces are electropolished and mechanically abraded simultaneously is a method of mirror surface polishing known in the art. However, it has proved difficult to apply uniform electrolytic current and voltage in the polishing of workpieces having secondary and tertiary curved surfaces. Therefore, the electrolytic composite polishing was limited to the polishing of planar surfaces. This method was also disadvantageous as it was costly and required complex apparatus.

An object of the present invention is to provide a new and improved buffing method which can be used to provide smooth workpieces of various profiles, especially workpieces having curved surfaces and corners, in a manner as simple as prior art buffing methods, and whereby a substantially

scratch-free mirror finished surface, which could not be obtained by the prior art buffing methods, is obtained at a reasonable cost.

In general, prior art buffing processes comprise applying an abrasive compound to a buff, rotating the buff at a high speed, and pressing a workpiece against the rotating buff. In the finish buffing stage, a grease-based buffing composition in which abrasive grains are covered with fats or waxes of animal, vegetable or mineral origin may be used to minimise scratching of the article by abrasive grains. The abrasive grains are not fixed to the buff surface, but allowed to move freely to some extent (that is, the abrasive grains are not fixed grains, but loose grains).

Since such abrasive grains have a coating of fats or waxes, the abrasion by abrasive grains themselves and the reaction between the lubricating fats or waxes and the workpiece metal (resulting in formation of metal soap) takes place in a co-operative manner to achieve, in combination, smoothing and mirror finishing, especially at high temperature and high pressure. In addition, the action imparted to the workpiece varies with the nature, size and type of abrasive grains. In general, as abrasive grains increase in size and hardness, a greater cutting force is obtained and a deeper groove or scratch is cut.

The mirror finishing technique, also known as finish buffing, often uses submicron grains of iron oxide, chromium oxide and aluminum oxide or grains of very low hardness materials such as calcium carbonate and amorphous silica. However, it has proved difficult to completely or substantially eliminate scratches associated with abrasive grains at high temperature and pressure. In fact, attempting to buff parts using abrasive compounds prepared from fats or waxes containing no abrasive grains, the inventors found that the parts were damaged by the contact between the buff and the

parts. Thus, the conventional methods fail to produce a scratch-free surface.

Nevertheless, the buffing process is of interest since the mechanism is simple and the facility cost is low. Continuing investigations on the mirror finishing by a buffing process, it has been found that buffing can be accomplished to a substantially scratch-free mirror finish by dispersing abrasive grains having a mean grain size of up to 0.5 µm in water in a concentration of 3 to 20% by weight to form a slurry, adjusting the slurry to pH 1 to 5, with nitric acid, phosphoric acid or a nitrate such as aluminum nitrate and supplying the slurry to a buff.

Conventional final finish buffing can smooth workpieces to a maximum surface roughness Rmax of 0.1 µm at best, which is best finish presently available This order of roughness means that scratches on the surface can be visually identified in sunlight or under fluorescent lamps. In contrast, the buffing method of the present invention is successful in smoothing workpieces to a maximum surface roughness Rmax of substantially lower than 0.1 µm, especially to 1/3 of the best results according to conventional methods.

A visual observation of surfaces having an Rmax of lower than 0.1 µm in sunlight or under fluorescent lamps cannot identify the presence of scratches by abrasive grains. As a consequence, the buffing method of the present invention provides a scratch free lustrous surface which is substantially improved in outer appearance over those obtained by the conventional buffing methods.

It is suggested that the scratch-free lustrous surface is obtained for the following reason although the present invention is not bound to the theory. As previously described, the conventional buffing mechanism relies on

overall interactions among fats or waxes, abrasive grains, and the buff at high temperature and pressure, including reaction between the fatty acid and the metal, and the cutting action of abrasive grains. The abrasive grains have such a cutting force that deep scratches are formed.

The present invention carries out buffing without using fats or waxes, preferably by rotating the buff at a moderate peripheral speed of 600 m/min. or lower such that excessively high temperature and pressure conditions are not induced. While abrasive grains in the slurry develop cutting action,nitric acid, nitrate or phosphoric acid in the slurry undergoes a weak reaction to dissolve the workpiece surface so that the scratched surface caused by abrasive grains may be chemically dissolved or removed by the dilute reactive acid. Since the workpiece surface on which abrasive grains act remains activated immediately after grinding, it is appropriately dissolved by the mildly acidic slurry of nitric acid, nitrate or phosphoric acid at pH 1 to 5 without the risk of excess etching.

Thus, an embodiment of the present invention provides a method for buffing a surface of a workpiece comprising the steps of rotating a buff having and abrasive compound applied there to and pressing the workpiece against the buff. The abrasive compound is a slurry having 3 to 20% by weight of abrasive grains with a mean grain size of up to 0.5 µm dispersed in water. The slurry is adjusted to pH 1 to 5 with nitric acid, phosphoric acid or a nitrate.

The buffing method of the present invention is effective in buffing various surfaces, including stainless steel and other metals, chromium plated surfaces, paint coated surfaces,and anodized surfaces to mirror finished surfaces as the final finish. In this respect, the buffing method of the present invention preferably starts with workpieces which have been polished to a maximum surface roughness Rmax of up to

0.5 µm.

A maximum surface roughness Rmax of up to 0.5 µm may be imparted to workpieces by various conventional methods. For example, a process including consecutive steps of emery polishing, cutting down using a sisal mop, and intermediate finish polishing using a cotton buff may be used to polish the workpieces to an Rmax of up to 0.5 µm.

According to an embodiment of the present invention, the thus polished workpieces are buffed by means of a buff wheel to which an abrasive compound is applied. The abrasive compound used is a slurry which is prepared by dispersing abrasive grains having a mean grain size of up to 0.5 µm in water in a concentration of 3 to 20% by weight and adjusting the slurry to pH 1 to 5 with nitric acid, phosphoric acid or nitrate.

The abrasive grains used herein are of materials substantially inert to acids, for example, alumina, chromium oxide, iron oxide, fused alumina, Alundrum [R] (Norton Co.,Metals Division, Al_2O_3), and Carborundum [R] (Harbison-Carborundum Corp). These materials may be used alone or as a mixture of two or more of them. The abrasive grains have a mean grain size of up to 0.5 µm, preferably 0.3 to 0.4 µm. In particular, the exclusion of coarse grains having a size of more than 1 µm is preferred in order to prevent scratching. The grains are contained in the slurry in a concentration of 3 to 20% by weight, preferably 3 to 10% by weight of the total weight of the slurry.

The slurry contains at least one component selected from the group consisting of nitric acid, phosphoric acid, and nitrate salt. Suitable nitrates include aluminum nitrate,nickel nitrate, cobalt nitrate, and zinc nitrate. Aluminum nitrate is the most preferred acidic component. Typically the acidic component is added in an amount of 0.1 to

2% by weight,preferably 0.2 to05% by weight of the total weight of the slurry. Less than 0.1% of the acid is generally insufficient to provide a necessary pH level to ensure the desired dissolving action. Too much acid will cause excess dissolving, that is, etching, resulting in an impaired appearance. The slurry is adjusted to pH 1 to 5, typically pH 1 to 4 and preferably pH 1 to 3, with the acidic component.

If desired, the slurry may contain an oxidizing agent such as hydrogen peroxide. Also, a surface active agent may be added for uniform buffing and promoted cleaning. Polyethylene glycol nonylphenyl ether is a typical surface active agent and may be used in an amount of about 0.1 to about 0.2% by weight of the slurry.

The buff to which the slurry is applied is preferably made of a water absorbing material so that the slurry may be retained therein. For example, fabrics of water absorbing fibres are used in the form of felt, flannel, and fabrics of spongy synthetic fibres are appropriate. The diameter of the buff generally ranges from about 10 to about 250 mm although it depends on the size of the workpieces to be treated. The slurry may be supplied to the buff by various method including gravity dripping, spraying, and pumping.

The operation of the buff according to the present invention is carried out in a manner well known for conventional buffing methods. Preferably, the buff is rotated at a relatively low speed. In this regard, the conventional final finish buffing using a grease base buffing composition containing chromium oxide or the like as an abrasive grain, is designed to rotate the buff wheel at about 2,000 to 3,000 rpm. In the practice of the present invention, the buff rotation is preferably set to 100 to 1,000 rpm to limit the peripheral speed to 600 m/min. or lower for achieving better buffing results. This is because, if the number of buff revolutions and hence, peripheral speed is too high, then the abrasive

compound in slurry form can be centrifugally spread out and dispersed such than an increased amount of abrasive compound is necessary to be effective.

The amount of abrasive compound or slurry fed to the buff is typically about 5 to 20 ml for a single buffing operation. The operating time generally ranges from 1 to 30 seconds although again, it varies according to the particularly workpiece.

In practicing the buffing method of the present invention, as an acidic slurry is used, the buffing apparatus is preferably received or housed in an enclosure so that the slurry may not spread over the environment. Further, the slurry may be stored in a tank and supplied to the buff by any desired supply means (as previously described) for impregnating the buff therewith. The used slurry may be returned to the tank for recycling and reuse.

EXAMPLES

Examples of the present invention are given below by way of illustration and not by way of limitation. Rmax is a maxium surface roughness.

<u>Example</u>

The workpieces were stainless steel dinner knives having an Rmax of 7 to 10 µm on their handle. The knife handles were subjected to polishing by an emery abrasive belt and then sisal buffing by means of Cutter V (manufactured by C. Uyemura & Co., Ltd.) using alumina abrasive grains, to Rmax of 0.6 to 0.8 µm. For intermediate finishing, the knife handles were subjected to cotton buffing by means of Trainer 10 (manufactured by C. Uyemura & Co., Ltd.) using alumina abrasive grains, to Rmax of 0.2 to 0.3 µm.

The buff used was a felt wheel having a diameter of 150

mm. It was rotated at 400 rpm or a peripheral speed of 188 m/min. while a slurry of the following composition was sprayed onto it through a spray gun. The workpieces were then buffed by pressing them against the rotating buff. For one buffing operation, the amound of the slurry sprayed was 4 ml and the operating time was 5 seconds.

Slurry composition

Aluminum nitrate	15 g/l
Alumina (mean grain size 0.45 μm)	100 g/l
pH4	

At the end of buffing operation, the workpieces were washed with a neutral detergent and then with warm water, and dried.

Comparative Example

Knife handles were finished to an Rmax of 0.2 to 0.3 μm by belt polishing, sisal buffing, and cotton buffing in the same manner as in the Example. The knife handles were buffed by a conventional final finish buffing method using a pieced cotton buff having a diameter of 150 mm together with a grease-base buffing composition of rod type. The buff was rotated at 2400 rpm. The composition in which chromium oxide abrasive grains with a mean grain size of 0.5 μm were bonded in fatty acids, hardened oil and wax was commercially available as blue rough GX-1 from C. Uyemura & Co., Ltd. The rod was coated to the buff in an amount of 5 grams per buffing operation. Buffing was conducted by pressing the workpiece against the rotating buff for 5 seconds.

At the end of the buffing operation, the workpieces were degreased with trichloroethylene, washed, and then dried.

The workpieces (knife handles) buffed in the Example and

in the Comparative Example were analysed for surface roughness using surface roughness meter Surfcom Model 1500 (Tokyo Seimitsu K.K.) with a magnifying power of X 100,000. Measurements at four sites were averaged. The results are shown in Table 1.

Table 1: Roughness in μm

	Ra	Rt	Rz.D	RMS	Rmax	Rz
Comparison	0.0043	0.0863	0.0583	0.0068	0.1003	0.0715
Example	0.0012	0.0350	0.0168	0.0020	0.0585	0.0318

As seen from Table 1, the workpieces buffed according to the present invention on the surface had an Rmax of about 0.6 μm which was substantially lower than the Rmax of about 0.1 μm achieved by the conventional buffing method. This order of surface roughness indicated that no scratches would be visually identified under sunlight and fluorescent lamps. In fact, a visual observation showed that the surface buffed according to the present invention was a lustrous smooth surface without cut grooves. A great difference was recognized from the surface buffed in Comparative Example which presented identifiable cut grooves and had a white appearance due to scratches.

There has been described a method for buffing a workpiece to a scratch-free lustrous mirror finished surface. The post-treatment is relatively simple because no fats or waxes are used, no containiminant is left on the buffed surface, and washing with organic solvents such as trichloroethylene is omitted.

Although some preferred embodiments have been described, many modifications and variations may be made thereto in the light of the above teachings.

At its broadest the present invention can be seen as comprising a method of buffing a surface of an article by contacting the surface with a rotating buff and supplying an abrasive or buffing composition to the buff, wherein the abrasive agent comprises a slurry containing abrasive grains having a mean grain size of up to 0.5 µm in an acidified solution having a pH of no greater than 5.

CLAIMS

1. A buffing composition comprising a slurry containing 3 to 20% by weight of abrasive grains with a mean grain size of up to 0.5 µm dispersed in water and adjusted to pH 1 to 5 with an acidic component which is one or more of nitric acid, phosphoric acid, and a nitrate.

2. A composition according to claim 1 wherein the abrasive grains are one or more of aluminum oxide, chromium oxide, iron oxide, and silicon carbide.

3. A composition according to claim 1 or 2 wherein the acidic component comprises from 0.1 to 2% by weight of the slurry.

4. A composition according to any preceding claim wherein the acidic component is aluminum nitrate.

5. A method of buffing a surface of an article which comprises rotating a buff containing a buffing composition applied thereto and contacting the surface with the buff, wherein the composition is a slurry having 3 to 20% by weight of abrasive grains with a mean grain size of up to 0.5 µm dispersed in water and adjusted to pH 1 to 5 with an acidic component which is one or more of nitric acid, phosphoric acid, and a nitrate.

6. A method according to claim 5 wherein the buff is rotated at a peripheral speed of up to 600 m/min.

7. A method according to claim 5 or 6 wherein the article has an Rmax of up to 0.5 µm prior to buffing and is buffed to an Rmax of up to 0.1 µm.

8. A composition and/or method substantially as hereinbefore described with reference to the Example.

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